DOCUMENT RESUME

ED 260 131 TM 850 476

AUTHOR Anderson, Paul S.; Kanzler, Eileen M.
TITLE Comparison of Cognitive Achievement in Objective Testing: Multi-Digit and Multiple-Choice Tests.
PUB DATE 4 Apr 85
NOTE 7p.; Paper presented at the Annual Meeting of the American Educational Research Association (69th, Chicago, IL, March 31-April 4, 1985). Figures contain small print.
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Achievement Tests; *Cloze Procedure; Comparative Testing; Computer Assisted Testing; *Difficulty Level; Guessing (Tests); Higher Education; Knowledge Level; *Multiple Choice Tests; *Objective Tests; Recall (Psychology); Scores; Secondary Education; Student Attitudes; Test Construction; *Test Format
IDENTIFIERS *Multi Digit Tests

ABSTRACT

Test scores were compared for two types of objective achievement tests--multiple choice tests and the recently developed Multi-Digit Test (MDT) procedure. MDT is an approximation of the fill-in-the-blank technique. Students select their answers from long lists of alphabetized terms, with each answer corresponding to a number from 001 to 999. The answer sheets are scorable by computer. The results of previous research, as well as recent research in college undergraduate and high school classes, are both inconclusive. Some of the studies indicate advantages for the fill-in-the-blank style of test items, while other studies show no difference. No study has demonstrated that multiple choice testing resulted in superior test achievement. When students were questioned about their opinion of MDT, about half found it less desirable than multiple choice tests, yet preferable to open-ended fill-in-the-blank questions. About half considered MDT to be equal to or preferable to multiple choice tests. There was also some indication that study habits were different when students expected to be given MDT rather than multiple choice tests or traditional fill-in-the-blank tests. (GDC)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED260131

COMPARISON OF COGNITIVE ACHIEVEMENT IN OBJECTIVE TESTING: Multi-Digit and Multiple-Choice Tests

Dr. Paul S. Anderson
Department of Geography-Geology
Illinois State University
Normal, IL 61761
(309) 438-7360

Dr. Eileen M. Kanzler
Social Studies Department
University High School
Illinois State University
Normal, IL 61761

(A paper presented to the conference of the National Educational Research Association (AERA), in Chicago, Illinois, on April 4, 1985.)

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
P.S. Anderson
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
☒ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

ABSTRACT

Two objective test methods are examined to determine which yields higher cognitive achievement. The Multi-Digit Test (MDT) procedure, available for only two years, is a computer scored approximation of fill-in-the-blank questions, which facilitates question writing and improves feedback to students and teachers. The students select their answers from long lists of alphabetized terms, each with a number up to 999 on the 3-digit format. Previous comparative research plus recent work specifically on the Multi-Digit Test are all similarly inconclusive. Some results show advantages for fill-in-the-blank style questions; other results show no difference; no study says that multiple-choice is superior for cognitive achievement. Recent development and availability of the Multi-Digit Test will permit others to research and utilize this additional evaluation method.

I. Introduction and Background

This paper examines the effectiveness and influence of the Multi-Digit Test on cognitive achievement in comparison with the traditional multiple-choice test. The research described here focuses only on examination material which could be handled by either of the methods and also by the fill-in-the-blank method, i.e., when the answer is a discrete term or name. The objective is to be constructive, adding something new for specific applications while not detracting from the existing test methods, each with its own particular rationale.

Objective tests such as multiple-choice, true-false, and matching are frequently criticized as being too trivial or for encouraging guessing in a context of answer recognition. They are also faulted for taking too much of the teacher's time to compose properly. However, they are credited with the advantage of being easier and quicker to grade than the open response fill-in-the-blank tests which require recall. Whatever the advantages and disadvantages of objective tests, they are a mainstay of high school and college testing procedures and are the principal devices used in standardized tests. Yet clearly part of their content could be handled by the fill-in-the-blank method.

II. The Multi-Digit Test (MDT)

To diversity classroom objective tests, an instrument has been needed to evaluate large numbers of students while avoiding the guessing and recognition possibilities of the 5-10 foil multiple-choice test. At the same time the method should not require the time consuming manual grading of the fill-in-the-blank format. A new testing method which incorporates these features has been developed and in use since January 1983. It is called the Multi-Digit Test (MDT), wherein after reading the questions the students must have their answers in mind before referring to a list of several hundred alternatives arranged in alphabetical order. (See a sample list in Figure 1.) The code numbers of the selected answers are recorded

TM 850 476

Figure 1: Part of an MDT "lexicon-list"

MDT LISTS OF BASIC GEOGRAPHICAL FEATURES CONCEPTS AND TERMS FOR WORLD GEOGRAPHY

A

Special List A of Concepts and Terms

1 Absolute Location
2 Accessibility
3 Acculturation
4 Age of Discovery
5 Agricultural
6 Alienation
7 Alluvium
8 Altitudinal
9 Assimilation
10 Barrio
11 Bedrock
12 Beneficiation
13 Biomass
14 Break-in-Bulk
15 Campesinos
16 Capital-Surplus/Oil-Exporting
17 Catholicism
18 Centripetal
19 Central Place
20 Chernozem
21 Circle of Illumination
22 Climate-- Humid Subtropical
23 Climate-- Humid Continental
24 Climate--Desert
25 Climate--Ice Cap
26 Climate--Marine West Coast
27 Climate--Mediterranean
28 Climate--Rainforest
29 Climate--Steppe
30 Climate--Subarctic
31 Climate--Tundra
32 Climate--Uplands and Mountains
33 Club of Rome
34 Complementarity
35 Condensation
36 Coniferous
37 Conspicuous Consumption
38 Continentality
39 Convection
40 Convergence
41 Creole
42 Culturel
43 Deciduous
44 Developing
45 Development
46 Dew Point
47 Direct Rays
48 Direction--Counter-Clockwise
49 Direction--Clockwise
50 Direction--East to West
51 Direction--NE to SW
52 Direction--NW to SE
53 Direction--No Major Movement
54 Direction--North to South
55 Direction--SE to NW
56 Direction--SW to NE
57 Direction--South to North
58 Direction--West to East
59 Divergent
60 Dual Economy
61 Dual Societies
62 Ecumene
63 Effective National Territory
64 Ejidos
65 Emergent
66 Encomienda
67 Environmental Degradation
68 Environmental Determinism
69 Environmental Perception
70 Equator
71 Equinox
72 Erosion
73 Ethnocentrism
74 Exploitation
75 Expropriation
76 Extended Families
77 Fall Line
78 Fatalism
79 Fault
80 First World
81 Front
82 Ghetto
83 Glaciation
84 Glaciers
85 Gradation
86 Gross National Product (GNP)
87 Growth
88 Haciendas
89 Hinterland
90 Holistic
91 Hollow Frontier
92 Humus
93 Industrial Revolution
94 Industrialization
95 Industrialized
96 Koppen
97 Land Tenure
98 Latifundio
99 Latitude
100 Leaching
101 Least Developed
102 Leeward
103 Long Lots
104 Longitude
105 Malthus
106 Megalopolis
107 Melting Pot
108 Meridian
109 Mestizo
110 Migration
111 Minifundio
112 Mixed Farming
113 Moraine
114 Neocolonialism
115 Neolithic
116 Newly Industrialized
117 Occluded
118 Orographic
119 Pangea
120 Parallel
121 Paramos
122 Parasitic
123 Peasants
124 Pedalfers
125 Pedocals
126 Per Capita Income
127 Perifery
128 Piedmont
129 Plate Tectonics
130 Pluralism
131 Podzols
132 Population Pyramid
133 Poverty
134 Prairie Wedge
135 Precipitation
136 Prevailing Wind
137 Primary
138 Prime Meridian
139 Quality of Life
140 Rain Shadow
141 Relative Deprivation
142 Relative Location
143 Resource
144 Resurgent
145 Revolution
146 Rotation
147 Rural Isolation
148 Second World
149 Secondary
150 Seigneur
151 Seventh Approximation
152 Shifting Cultivation
153 Site
154 Situation
155 Slash-and-Burn (Swidden)
156 Social Mobility
157 Socioeconomic
158 Soil
159 Solstice
160 Spatial Interaction
161 Specialization
162 Stationary
163 Strip Mining
164 Structural
165 Subduction
166 Submergent
167 Subsistence
168 Technological Revolution
169 Tectonic Forces
170 Tertiary
171 Third World
172 Tierra Caliente
173 Tierra Fria
174 Tierra Templada
175 Tilt
176 Toffer (Author)
177 Topography
178 Transferability
179 Treaty of Tordesillas
180 Underdeveloped
181 Undeveloped
182 United Nations
183 Urban Shadow
184 Vertical (see altitudinal)
185 Windward
186 Xerophytic
187 Zambos

List of Geographical Features

A
201 Abidjan
202 Abidjan
203 Accra
204 Adamaoua
205 Addis Ababa
206 Adea
207 Adirondack
208 Adriatic
209 Aegean
210 Afghanistan
211 Africa
212 Alabama
213 Alaska
214 Albania
215 Albany
216 Alberta
217 Aleutian
218 Alexandria
219 Algeria
220 Algiers
221 Allegheny
222 Alps
223 Alsace
224 Amazon
225 American Samoa
226 Amman
227 Amsterdam
228 Amu Darya
229 Amur
230 Anchorage
231 Andes
232 Andorra
233 Angola
234 Ankara
235 Annapolis
236 Antarctic Circle
237 Antarctica
238 Antigua and Dependencies
239 Antilles, Greater
240 Antilles, Lesser
241 Antiplano
242 Appalachian
243 Appennines
244 Aquaba
245 Arabian
246 Aral
247 Arctic
248 Arctic Circle
249 Argentina
250 Arizona
251 Arkansas
252 Armenia
253 Aruba
254 Ascension
255 Asia
256 Asuncion
257 Atacama
258 Athens
259 Atlanta
260 Atlantic
261 Atlantic Coastal Plain
262 Atlas
263 Auckland
264 Augusta
265 Austin
266 Australia
267 Australian Alps
268 Austria
269 Azerbaidzhan
270 Azov
B
271 Bab-El-Mandeb
272 Baffin
273 Baghdad
274 Bahamas
275 Bahrain
276 Baikal
277 Balkan
278 Baltic
279 Baltimore
280 Bangkok
281 Bangladesh
282 Barbados
283 Barents
284 Barisan
285 Basque
286 Baton Rouge
287 Beirut
288 Belem
289 Belfast
290 Belgium
291 Belgrade
292 Belize
293 Belorussia
294 Bengal
295 Benin
296 Bergen
297 Bering
298 Berlin
299 Bermuda
300 Bern
301 Bhutan
302 Birmingham
303 Biscay
304 Bismarck
305 Black
306 Blue Nile
307 Bogota
308 Boise
309 Bolivia
310 Bombay
311 Bonn
312 Borneo
313 Bosporous
314 Bothnia
315 Botswana
316 Brahmaputra
317 Brasilia
318 Brazil
319 Brazilian Highlands
320 Brazzaville
321 Brisbane
322 British Columbia
323 Brocks
324 Brunei
325 Brussels
326 Bucharest
327 Budapest
328 Buenos Aires
329 Bulgaria
330 Burma
331 Burundi
C
332 Cadiz
333 Cairo
334 Calcutta
335 Calgary
336 California
337 Cambodia
338 Cameroon
339 Canada
340 Canadian Shield
341 Canberra
342 Cancer, Tropic of
343 Cantabrian
344 Canton
345 Cape Town
346 Cape Verde
347 Capricorn, Tropic of
348 Caracas
349 Caribbean
350 Carpathian
351 Carpentaria
352 Carson City
353 Cascade
354 Caspian
355 Caucasus
356 Cayman
357 Celebes
358 Central
359 Central African Republic
360 Central America
361 Chaco, Gran
362 Chad
363 Charleston
364 Cheyenne
365 Chicago
366 Chile
367 China (Nationalist)
368 China (Peoples Republic)
369 Chungking
370 Cleveland
371 Coast Range
372 Colombia
373 Colombo
374 Colorado
375 Columbia
376 Columbus
377 Comoros
378 Concord
379 Congo
380 Connecticut
381 Cook Islands
382 Copenhagen
383 Corsica
384 Costa Rica
385 Crete
386 Cuba
387 Cyprus
388 Czechoslovakia
D
389 Dacca
390 Dallas
391 Damascus
392 Danube
393 Dar Es Salaam
394 Dardanelles
395 Darling
396 Darwin
397 Dead Sea
398 Death Valley
399 Deccan
400 Delaware
401 Denmark
402 Denver
403 Des Moines
404 Detroit
405 Dinaric Alps
406 District of Columbia
407 Djakarta
408 Djibouti
409 Dnieper
410 Dominica
411 Dominican Republic
412 Don
413 Drakensburg
414 Dublin
E
415 East [illegible]
416 Eastern
417 Eastern Siberia
418 Ecuador
419 Edinburgh
420 Edmonton
421 Egypt
422 El Salvador
423 Elbe
424 Elburz
425 England
426 English
427 Equatorial Guinea
428 Erie
429 Eritrea
430 Estonia
431 Ethiopia
432 Ethiopian Highland
433 Euphrates
434 Europe
435 Everest
436 Everglades

NOTE: The back side of this page contains one continuous list from F to Z.

on a optically scanable answer sheet. A three-digit sheet presently in use can accommodate up to 999 code numbers. (See Figure 2.)

Students preparing for the MDT questions must study for recall rather than recognition. There are also other advantages. Once the answer lists are prepared the teacher has more flexibility and opportunity to compose and utilize a greater variety of questions. Computer scoring offers rapid grading and a full contingent of statistical analysis. Furthermore, the feedback to the students is greatly enhanced because the computer has a lexicon of responses that match the thousand alternative answers. A further discussion of the characteristics of the Multi-Digit Test was written by Anderson (1984a).

The Multi-Digit Test has been used with over six hundred students during five semesters, the majority being enrolled in a freshman-level World Geography course. As expected, student reactions are mixed. Unfamiliarity with the method, an additional sheet of paper on the desk, and the increased question difficulty (in contrast to 5-choice questions on the same subject matter) lead about half of the students to consider the

Figure 2: MDT answer sheet (reduced size)

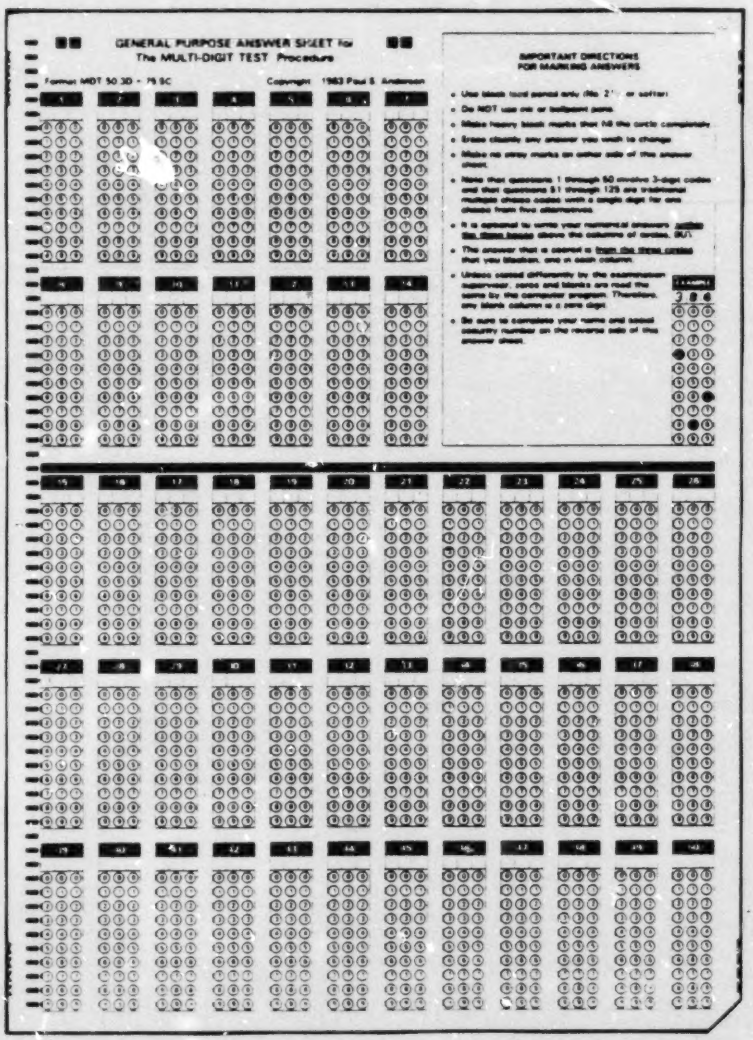
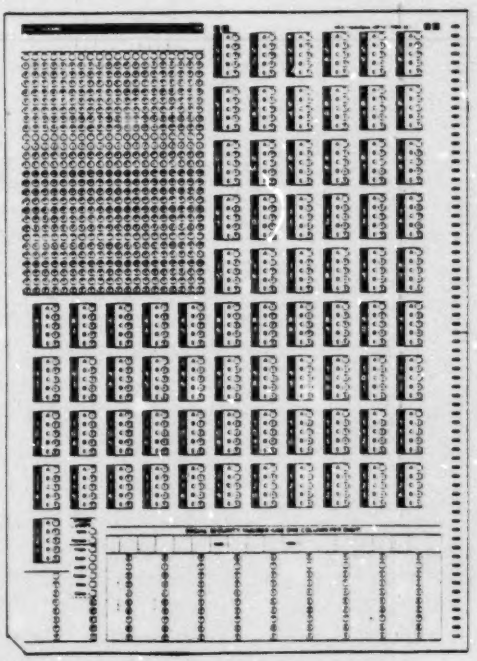


Figure 2B: Reverse side of MDT form



MDT method to be less desirable than the traditional multiple-choice method. However, those students readily prefer MDT when given the choice between it and full free-response questions (fill-in-the-blank).

About half of the students consider the MDT method to be equal to or preferred over the multiple-choice style. A sample of their comments include:
"...studied a great deal more...shows that the individual knows the material or not, he can't guess..." S.B.

"...really have to know the information..." S.N.

"First time taking an Exam like this!!! I like (it.)" G.T.

"I liked the MDT test system." T.H.

"...great ideal" L.A.

"...liked the idea...more effective in determining if the students really know the information..you either know it or you don't." R.B.

"I think the MDT test method is very effective in that it contains the best aspects of both the multiple choice test and the fill-in-the-blank test method. It negates the problem of lucky guessing common to multiple choice test but at the same time allows recall of answers "on the tip of your tongue" by being able to see the name on a list. It also doesn't bring with it the problem of learning how to spell strange names correctly, a problem common to fill-in-the-blank tests." P.D.

"...good test method..." K.B.

"I like the MDT method. I feel it provides a much more accurate score when an evaluation of a student's knowledge is being attempted...If I know I would be faced with a MDT test...the motivation to study would be greatly enhanced. MDT tests will raise retention and lower unearned grades." R.E.

III. Research on the Comparison of Cognitive Achievement

A. Previous Research: Student comments and apriori reasoning suggest that the Multi-Digit Test should result in some advantages in cognitive achievement when compared with the 5-choice method. Previous research efforts in this area by Duchastel (1981) and Duchastel and Nungester (1982) indicate the efficacy of recall and consolidation-retrieval of the short answer (fill-in-the-blank) test over the recognition/discrimination pattern of the multiple-choice test. The same "mental review" thought process required in the short answer test is present in the MDT method. Other comparable studies (Sax and Collett 1968, Gay 1980) yield inconclusive or unrelated results. Ward (1982) reported that the response format made no difference in the pattern of correlations among a set of verbal aptitude tests. Such a variety of results suggest that further research is necessary.

B. Research with the Multi-Digit Test: Research by Anderson, Hill, Naim and Walters (1985) compared three test methods (including MDT) on the place name portion of a World Geography course. Their exploratory research used a Latin Square/recurring measures methodology with 188 students during a semester-long comparison. The students were always advised as to the test method used for each segment of their course. An unannounced post-test provided the final data. Retention of cognitive learning was highest when the students had studied for their turn with the fill-in-the-blank method, second with MDT, and lowest with multiple-choice, exactly as hypothesized. Although only the fill-in-the-blank method yielded a statistically significant difference (retention approximately eight to ten percent greater than in the other two methods), the results are considered to be conservative because of limitations in the research methodology.

Subsequent and on-going research has been undertaken by the co-authors (Anderson and Kanzler) during the Fall 1984 and Spring 1985 semesters within the setting of the laboratory high school at Illinois State University. The advantages of that environment have been discussed in an earlier paper by Anderson and Kanzler (1985).

Three of the five U.S. History classes in the laboratory school were taught by Dr. Kanzler and were utilized in the research. All students had previously pre-registered into classes of about twenty-five students in a random fashion based on availability, requirements and electives. The pre-test and first two tests of the semester were identical for all three

groups in order to ascertain any noteworthy differences between the classes. The means and other descriptive statistics were essentially the same, and the 11 AM class was selected as the experimental (MDT) group.

For each of the bi-weekly tests the MDT format questions posed to the experimental group were converted to multiple-choice 4-foil format for the two control groups. Five to ten multiple-choice questions where reasoning or judgment was a factor in the answer were also included on most tests. For the third test (first one with MDT), no advance notice on the change of format was given to the experimental group. As anticipated the experimental group achieved a much lower mean score (52%) than either of the two control groups (74% and 71%). That is a decline of 28% from the average correct scores of the control groups. It was readily apparent to the students that the MDT based on recall was a much harder, more demanding test. When the same test was subsequently administered in a multiple-choice 4-foil format to the experimental group, those students achieved the same (72%) result as the control groups. A few students complained about the difficulty and fairness of the MDT test, not realizing that difficulty is at the discretion of the instructor, who could also have given fill-in-the-blank tests.

Attempts to treat the MDT as just another but longer form of matching test had to be dispelled by enforcing a time limit only slightly longer than the average time needed to complete a multiple-choice test of equal length. The "search" for the correct answer by random scanning of lists or by elimination attempts is apparently a difficult habit to break.

After the first few administrations of the MDT tests, the students realized that they would have to modify their study habits to accommodate the recollection of factual evidence. Some resisted this and dismissed the material as trivial, insignificant and irrelevant. This too is at the discretion of the teacher and is not a criticism of the Multi-Digit Test. Since most students apparently rely heavily on the recognition factor present in multiple-choice tests, some objected to the time and effort required by the demands of the recall strategy. Other students claimed that the change in study habits was impairing their performance on the multiple-choice section of tests where more judgment and reasoning were required. That was apparently not the case because an analysis of the multiple-choice segment of the final examination revealed that the students in the experimental group did as well if not slightly better than the control groups.

As the semester continued the experimental group made noticeable gains, at times attaining scores equal to those of the groups with the multiple-choice tests. However, their performance on the comprehensive final exam was disappointing (25% lower), but the sheer volume of information was probably a major factor. On one occasion the control groups were given both formats of the test with the MDT format coming first and being unannounced. Their MDT results averaged 42% lower than their own multiple-choice scores and 37% lower than the MDT scores of the experimental group. During the present spring semester, most of the students are still enrolled in Dr. Kanzler's second semester history classes. Further data collection, including a post-test in May, will yield additional results.

C. Summary: In general, the research efforts to date have not shown dramatic improvements in learning and retention that could be attributed to the Multi-Digit Test. On the other hand, no evidence even hints at any detrimental effect when MDT or open response methods are applied to appropriate subject matter. There are sufficient indications of possible benefits to merit further research. Very clearly, with questions which can be answered with a discrete term or name like those on the lists, the MDT method is more rigorous and students respond in a desirable way to that rigor. Although many students indicate that their study habits are modified, the qualitative and quantitative aspects of that modification have not been clearly identified.

IV. Conclusions and Future Work

The work on the Multi-Digit Test over the past two years indicates that it has definite applications in an important niche in computer-scored testing. Further variations of those applications will be found when additional disciplines give consideration to the MDT method. At present, MDT has only been used in selected courses of geography, history, home economics, and music. Virtually every discipline that has a

component of key vocabulary or content (like chemical elements) could utilize the Multi-Digit Test. Actual numeric answers of up to three digits (with the decimal point indicated in the stem of the question) provide new avenues for applications in a variety of quantitative subjects. Much more research on both the applications and the pedological issues is needed.

Work on the Multi-Digit Test is continuing at Illinois State University where larger samples and more disciplines are becoming involved. Other colleges and universities are invited to enter this research. An array of answer sheets, computer programs, long lists, and written guidelines are available for people interested in research on the method or interested simply in introducing it into their testing structures. The Department of Geography-Geology at Illinois State University is at present preparing for the dissemination of the materials to interested schools which commit to undertake research and evaluation of the Multi-Digit Test. A system of full or partial grants has been established to assist those schools or individuals in implementing the Multi-Digit Test. (Those interested should contact Dr. Anderson at the address given above.) It is anticipated that at some future conferences further presentations and possibly whole sessions could be devoted to the applications of the Multi-Digit Test.

Bibliography

Anderson, Paul S. (1984a), "An Introduction to the Multi-Digit Test (MDT)", Discussion Papers in Geography, No. 2, "Objective Testing in Geography", Old Dominion University, Norfolk, Virginia, pp. IV-1 to IV-18. (Originally presented as "Introduction to the Large-List Multi-Digit Test Procedure: With Examples From A World Geography Course", a paper at the West Lakes Regional Conference of the Association of American Geographers, Iowa City, Iowa, November 3-5, 1983.)

Anderson, Paul S. (1984b), "Applications of the Multi-Digit Test (MDT) Procedure for Teaching the Geography of Latin America", a paper presented at the Conference of Latin Americanist Geographers (CLAG), Ottawa, Canada, September 27-29, 1984. (A summary of this paper was published in CLAG Communication, Newsletter No. 50, December 1984, pp. 2-3)

Anderson, Paul S., Miriam H. Hill, Shamim Naim, and William D. Walters Jr. (1985), "Comparison of Cognitive Retention from Three Testing Methods: Fill-in-the-Blank, Multiple Choice and the Multi-Digit Test (MDT)". Illinois School Research and Development, Journal of the Illinois Association for Supervision and Curriculum Development, Normal, Illinois, Vol. 21, No. 1, Winter 1985, pp. 28-37. (Originally presented as "The Multi-Digit Test Procedure: Refinements and Preliminary Results," a paper at the international conference of the National Council for Geographic Education, Toronto, Canada, 17-20 October 1984.)

Anderson, Paul S. and Eileen M. Kanzler (1985), "Laboratory Schools As A Unique Setting For Research: The Experimentation with the Multi-Digit Test (MDT) at Illinois State University High School," a paper presented at the conference of the National Association of Laboratory Schools, in Denver, Colorado, on 26-28 February 1985.

Cook, Desmond L. (1955), "An Investigation of Three Aspects of Free Response and Choice Type Tests at the College Level," Ph.D. Dissertation, Dissertation Abstracts, University of Iowa.

Duchastel, Phillippe C. (1981), "Retention of Prose Following Testing with Different Types of Tests", Contemporary Educational Psychology, July 1981, Vol. 6, pp. 217-226.

Duchastel, Phillippe C., and Ronald J. Nungester. (1982), "Testing Effects Measured with Alternate Test Forms", Journal of Educational Research, May/June 1982, Vol. 17, No. 5, pp. 309-312.

Gay, Lorraine R. (1980), "The Comparative Effects of Multiple Choice Versus Short-Answer Tests on Retention", Journal of Educational Measurement, Spring 1980, Vol. 17, pp. 45-50.

Sax, G. and L. S. Collett. (1968), "An Empirical Comparison of the Effects of Recall and Multiple-Choice Tests on Student Achievement", Journal of Educational Measurement, Vol. 5, pp. 169-173.

Ward, William C. (1982), "A Comparison of Free-Response and Multiple Choice Forms of Verbal Aptitude Tests", Applied Psychological Measurement, Vol. 6, No. 1, Winter 1982, pp. 1-11.